IEEE P802.11
Wireless LANs

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| Resolution of MIMO-related CIDs |
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Abstract

This submission proposes resolutions to MIMO-related CIDs. The text used as reference is D1.3.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CID** | **Clause** | **Page** | **Comment** | **Proposed change** |
| 1886 | 30 | 216.03 | No TPC protocol for EDMG | "Need to extend the TPC protocol (802.11-2016) section 10.29.2 to support multiple Tx chains (e.g. MIMO case). Will provide a detailed submission about the solution." |
| 1993 | 30 | 216.03 | No TPC protocol for EDMG | "Need to extend the TPC protocol (802.11-2016) section 10.29.2 to support multiple Tx chains (e.g. MIMO case). Will provide a detailed submission about the solution." |

**Proposed resolution**: Revised

**Discussion:**

* To support TPC, the Link Measurement Report frame includes MCS, link margin, SNR, and activity fields, which are sent within the DMG Link Margin element.
	+ Two of the four parameters needed for multiple-stream TPC (SNR and MCS per space-time stream) can already be found in the “Parameters Across PPDUs” field
* Acknowledgement of TPC-related operations is performed with the DMG Link Adaptation Acknowledgement in the Link Measurement Report frame.
* Link Measurement Request frame: Indicate the transmit power used and the maximum transmit power of each transmit chain.

**Modifications:**

1. Changes to the DMG Link Margin element

*Modify the DMG Link Margin element defined in Figure 9-564, pages 97-98 as follows:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Activity | MCS | Link Margin | SNR | Reference Timestamp |
| Octets | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
|  | Rate Adaptation Control/Multiple Stream TPC | Parameters Across RX Chains | Parameters Across PPDUs | Parameters Across LDPC Codewords | Parameters Across SC Blocks or OFDM Symbols | Multiple Stream TPC |
| Octets | 5 | 0 or $N\_{RX}$ | 0 or $2N\_{STS}$ | 0 or $8N\_{STS}$ | 0 or $4N\_{STS}$ | 0 or $2N\_{STS}$ |

*Modify the paragraph in lines 3-5 of page 98 as follows:*

The Rate Adaptation Control/Multiple Stream TPC field contains the number of space-time streams reported ($N\_{STS}$) and indications of whether the element includes optional fields used for rate adaptation and/or TPC. The Rate Adaptation Control/multiple stream TPC field is defined in 9.4.2.142.3.

*Add the following definition after the paragraph in lines 13-15 of page 98:*

The Multiple Stream TPC field is optionally present. If present, as defined in defined in 9.4.2.141.8, it contains the activity and link margin of each of the space-time streams reported.

*Modify the Rate Adaptation Control (renamed as Rate Adaptation Control/Multiple Stream TPC) field format defined in Figure 29, page 98 as follows:*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Number of Rx chains Reported (NRX) | Number of Space-Time Streams Reported (NSTS) | Indication for Parameters Across PPDUs | Indication for Parameters Across LDPC Codewords | Indication for Parameters Across SC Blocks or OFDM Symbols | IsEDMG | IsSC | Number of PPDUs | Indication for Multiple Stream TPC | Reserved |
| Bits | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 16 | 1 | ~~13~~ 12 |

Rate Adaptation Control/Multiple Stream TPC field format

*Add the following text after the paragraph in lines 14-15 of page 99:*

The Indication for Multiple Stream TPC field is set to 1 if the DMG Link Margin element contains the Multiple Stream TPC field. It is set to 0 otherwise.

*Create a new subclause (9.4.2.141.8 – Multiple Stream TPC) after 9.4.2.141.7 and add the following:*

The Multiple Stream TPC field is defined in Figure 9-XX.

|  |  |  |
| --- | --- | --- |
|  | Activity  | Link Margin  |
| Bits | 8 | 8 |

Figure 9.XX - Multiple Stream TPC field format

The Activity subfield is set to a preferred action that the STA sending this element recommends that the peer STA indicated in the RA field of the Link Measurement Report frame execute for the space-time stream. The method by which the sending STA determines a suitable action for the peer STA is implementation specific. The Activity field is defined in 9.4.2.142.2.

The Link Margin field contains the measured link margin of the space-time stream received from the peer STA indicated in the RA field of the Link Measurement Report frame and is coded as a 2s complement signed integer in units of decibels. A value of –128 indicates that no link margin is provided. The method used to measure the link margin is beyond the scope of this standard.

2. Changes to the DMG Link Adaptation Acknowledgement element

*Modify Figure 9-535 of 802.11-2016 as follows:*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Activity | Reference Timestamp | Number of Space-Time Streams Reported ($N\_{STS}$) | Multiple Stream TPC Link Adaptation Acknowledgement |
| Bits | 8 | 8 | 8 | 8 | 3 | $$8×N\_{STS}$$ |

Figure 9-535—DMG Link Adaptation Acknowledgment element format

*Add the following at the end of 9.4.2.143*

The Number of Space-Time Streams Reported ($N\_{STS}$) subfield is optionally present. If present, it indicates the number of space-time streams being reported in the Multiple Stream TPC Link Adaptation Acknowledgement subfield. If the value of this field is greater than 0, the Activity field in the DMG Link Adaptation Acknowledgment element is reserved.

The Multiple Stream TPC Link Adaptation Acknowledgement subfield is only present if the value of the Number of Space-Time Streams Reported ($N\_{STS}$) subfield is greater than 0, and its format is shown in Figure 9-536.

|  |  |
| --- | --- |
|  | Activity |
| Octets | 1 |

Figure 9-536 – MIMO TPC Link Adaptation Acknowledgement field format

The Activity field within the MIMO TPC Link Adaptation Acknowledgement field is set to the action that the STA sending this element has executed following the reception of the recommended activity in a Link Measurement Report frame for the space-time stream. The method by which the sending STA determines the action is described in 10.39 and the Activity field is defined in 9.4.2.142.2.

3. Changes to the Link Measurement Request

*Modify Figure 9-651 of 802.11-2016 as follows:*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Category | Radio Measurement Action | Dialog Token | Transmit Power Used | Max Transmit Power | DMG Multiple Stream Measurement Request |
| Octets | 1 | 1 | 1 | 1 | 1 | variable (2$N\_{TX} )$ |

Figure 9-651 – Link Measurement Request frame Action field format

*Add the following at the end of 9.6.7.4*

The DMG Multiple Stream Measurement Request field is optionally present, and indicates the transmit power and the upper limit on the transmit power of each transmit chain used to transmit the frame containing the Link Measurement Request. If present, the Transmit Power Used field and the Max Transmit Power field in the Link Measurement Request frame are reserved. The format of the DMG Multiple Stream Measurement Request field is shown in Figure 9-652.

|  |  |  |
| --- | --- | --- |
|  | Transmit Power Used | Max Transmit Power |
| Octets | 1 | 1 |

Figure 9-652 – DMG Link Measurement Request element.

The Transmit Power Used field is set to the transmit power used by a transmit chain to transmit the frame containing the Link Measurement Request, as described in 9.4.1.20.

The Max Transmit Power field provides the upper limit on the transmit power of a transmit chain as measured at the output of the antenna connector to be used by the transmitting STA on its operating channel. This field is described in 9.4.1.19. The Max Transmit Power field is a 2s complement signed integer and is 1 octet in length, providing an upper limit, in a dBm scale, on the transmit power as measured at the output of the antenna connector to be used by the transmitting STA on its operating channel. The maximum tolerance for the value reported in Max Transmit Power field is ±5 dB. The value of the Max Transmit Power field is equal to the minimum of the maximum powers at which the STA is permitted to transmit in the operating channel by device capability, policy, and regulatory authority.

4. Changes to 10.39 (DMG link adaptation) (802.11-2016)

*Modify the first paragraph of 10.39.1 (General) as follows*

A STA may transmit a Link Measurement Request frame to request a STA indicated in the RA field of the frame to respond with a Link Measurement Report frame (9.6.7.5). If the Link Measurement Request frame is sent within a PPDU defined in Clause 20 or in Clause 30, the Link Measurement Report frame shall contain the DMG Link Margin element. The requesting STA may use values of the MCS, of the SNR and of the Link Margin to transmit frames to the STA indicated in the RA field of the Link Measurement Request frame.

*Add the following paragraph after the first one of 10.39.1 (General)*

If the Link Measurement Request frame is sent within a PPDU defined in Clause 30 that has the Number of SS field in the EDMG-Header-A set to a value greater than 0, the Number of Space-Time Streams Reported ($N\_{STS}$) field in the DMG Link Margin element within the Link Measurement Report frame shall be set to the same value. In this case, the requesting STA may use values of the MCS, of the SNR and of the Link Margin for each space-time stream to transmit frames to the STA indicated in the RA field of the Link Measurement Request frame using multiple stream transmission.

*Modify the eight paragraph of 10.39.1 (General) as follows*

The SNR field and Link Margin field in the Link Measurement Report frame shall indicate the corresponding measurements based on the reception of the PPDU that was used to generate the MCS feedback contained in the same Link Measurement Report frame. If the Link Measurement Report frame contains measurements of more than one space-time stream, the SNR Per STS subfield in the Parameters Across PPDUs field and the Link Margin subfield in the Multiple Stream TPC field in the Link Measurement Report frame shall indicate the corresponding measurements based on the reception of the PPDU that was used to generate the MCS feedback contained in the Parameters Across PPDUs field within the same Link Measurement Report frame.

*Modify the second paragraph of 10.39.2 (DMG TPC) as follows*

If the STA implements the recommendation indicated in the Activity field of ~~the~~ a Link Measurement

Report that does not include a Rate Adaptation Control/Multiple Stream TPC field, it shall send a Link Measurement Report frame containing a DMG Link Adaptation Acknowledgment element. The Activity field of the DMG Link Adaptation Acknowledgment element shall be set to the value of the Activity field in the received DMG Link Margin Subelement.

*Modify the third paragraph of 10.39.2 (DMG TPC) as follows*

If the STA does not implement the recommendation indicated in the Activity field of ~~the~~ a Link Measurement Report that does not include a Rate Adaptation Control/Multiple Stream TPC field, it may send a Link Measurement report containing a DMG Link Adaptation Acknowledgment element. The Activity field of the DMG Link Adaptation Acknowledgment element shall be set to 0~~, indicating that the STA did not change its transmit power~~.

*Add the following paragraph after the third paragraph of 10.39.2 (DMG TPC)*

If the STA implements the recommendation indicated in the Activity field of a Link Measurement

Report that includes a Rate Adaptation Control/Multiple Stream TPC field for one or more space-time streams, it shall send a Link Measurement Report frame containing a DMG Link Adaptation Acknowledgment element. The value of the Number of Space-Time Streams Reported field within the DMG Link Adaptation Acknowledgment element shall be set to the same value of the Number of Space-Time Streams Reported field in the DMG Link Margin element within the Link Measurement Report frame. If the STA implements the recommendation for a space-time stream, the Activity field of the DMG Link Adaptation Acknowledgment element shall be set to the value of the Activity field in the received DMG Link Margin Subelement of the same space-time stream. If the STA does not implement the recommendation for a space-time stream, the Activity field of the DMG Link Adaptation Acknowledgment element shall be set to 0.